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Performance of Morgan Horses Under Saddle

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CONTENTS

INTRODUCTION

Since 1941 the Bureau of Animal Industry has been conducting performance tests of 3-year-old Morgan horses for the purpose of determining the characters associated with performance and whether these characters are inherited and therefore can be used in the selection of breeding stock.

The three types of performance that have been studied are speed, endurance, and ease of riding. A large number of characters were measured or scored for each horse so that associations between them and performance could be determined.

Although many records on the performance of light horses have been made, the results have generally been difficult to interpret, according to Williams and Jackson (*12*).[3] Relatively few analyses have been made, and these have dealt with only certain phases, such as the relation of winning performances on the race track or in the show ring to ability to produce offspring which also win, as shown by Laugh-

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[2] The authors are indebted to S. R. Speelman, animal husbandman, and to W. V. Lambert and J. O. Williams, formerly animal husbandmen, of the Bureau, for assistance in planning the study and collecting the data.

[3] Italic numbers in parentheses refer to Literature Cited, p. 36.

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lin (*4, 5*), Jackson (*3*), and Steele (*11*). Few attempts have previously been made to devise and use objective tests under carefully controlled conditions similar to those in actual practice for ordinary saddle horses.

MATERIALS AND METHODS

Data were available on 79 three-year-old Morgan horses that were raised and trained at the United States Morgan Horse Farm, Middlebury, Vt. Eleven of these animals had a tendency to pace and were omitted from the study. The remaining 68 horses were sired by 8 different stallions and ranged from 2 to 25 offspring per sire. There

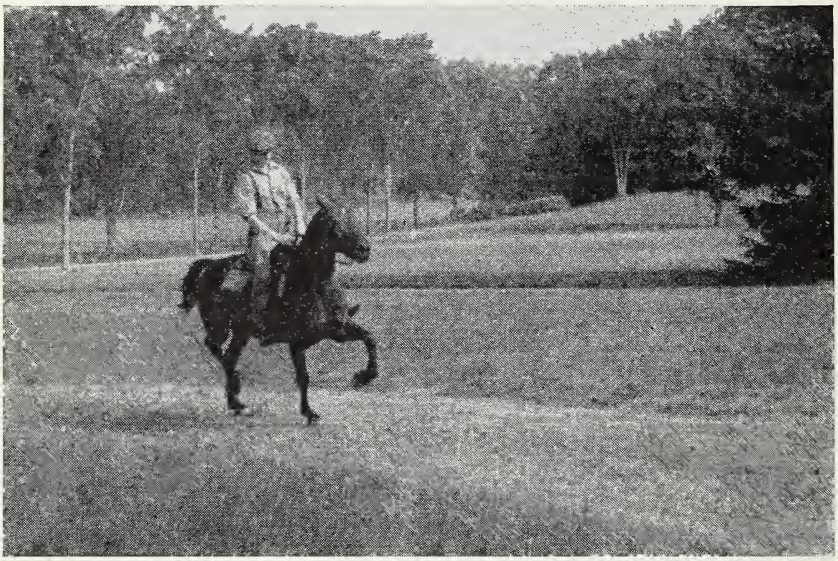

FIGURE 1.—Morgan mare Damsel being tested under saddle at the trot on the training track at Middlebury, Vt. Time for 1 mile, 4.2 minutes; stride, 12.3 feet.

were 6 stallions, 20 geldings, and 42 mares. Most of the horses were tested in the spring of the year that they were 3 years old. All data were not available on all horses. Distribution of the offspring by sires, years, and sexes is shown in table 1. The training and testing procedures have been described by Phillips, Speelman, and Williams (*9*) and Phillips (*6*), together with the general plan of the breeding program; hence only the tests under saddle are described here.

The tests under saddle included a 1-mile walk around an eighth-of-a-mile oval track, a 1-mile trot around the same track (fig. 1), and an 11.35-mile cross-country ride. The track had a surface of sand and clay and was smoothed and rolled at frequent intervals during the tests. The cross-country ride was on unpaved roads and over rolling country with several steep grades. During this ride each horse walked 4.65 miles, trotted 5.65 miles, and cantered 1.05 miles. Markers were placed along the course to indicate to the riders the gaits to be maintained over each portion, as shown in figure 2. Each horse

TABLE 1.—*Distribution of offspring of Morgan horses by sires, years, and sexes*

Sire	Year								Sex		
	1941	1942	1943	1944	1945	1946	1947	Total	Stallions	Geldings	Mares
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Mansfield	3	2	1	0	2	2	2	12	2	3	7
Abbott	0	6	0	0	0	0	0	6	0	2	4
Canfield	0	0	0	0	0	8	8	16	2	8	6
Delmont	2	0	0	0	0	0	0	2	0	0	2
Upwey King Peavine	0	2	0	0	0	0	0	2	0	0	2
Goldfield	0	1	4	6	14	0	0	25	2	7	16
Hudson	0	0	1	0	0	2	0	3	0	0	3
Laddie	0	0	0	0	0	0	2	2	0	0	2
Total	5	11	6	6	16	12	12	68	6	20	42

carried a load equivalent to at least 20 percent of its body weight. One pound of dead weight (bridle, saddle, and ballast) was considered equal to 2 pounds of live weight (rider). An effort was made to have the weight carried exactly equivalent to 20 percent of the body weight, but in some cases this was not possible, particularly with smaller horses, for which the weight of the available rider and a saddle

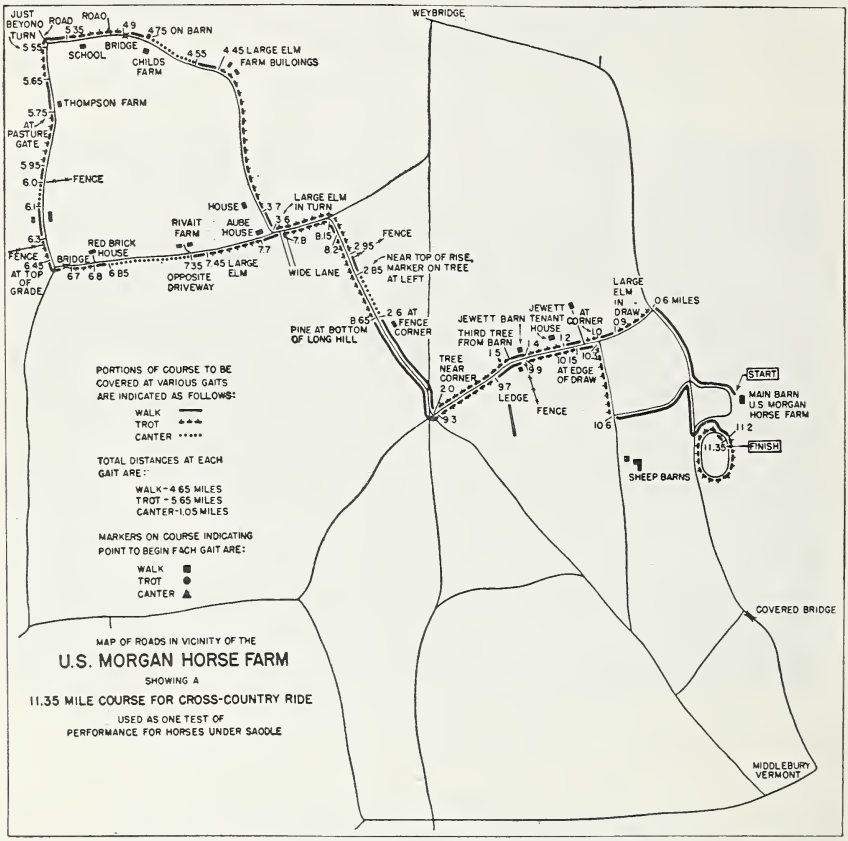

FIGURE 2.—Map showing 11.35-mile course for cross-country ride, one of the tests for performance of horses under saddle, United States Morgan Horse Farm, Middlebury, Vt.

somewhat exceeded the desired weight. Loading the horses on the basis of a percentage of body weight was an arbitrary procedure since data are not available on the relation of body weight to ability to carry a load. Work by Dawson (*1*), Phillips, Madsen, and Smith (*8*), and others has shown that light horses are able to pull relatively heavier loads for short distances in dynamometer tests than heavy horses, but no such tests have been conducted under saddle; hence an arbitrary basis had to be used.

Training of the horses began late in the fall and continued, except during the most inclement weather of the winter, until the recorded

tests were made in May. All animals were given approximately the same training. The horses were tested at their normal gaits without being pushed or allowed to lag. The test at the walk was given before the test at the trot with a 2-minute rest period between. The cross-country test was given on another day.

Speed and endurance were determined by trained observers—speed, by the time required to cover the total distance in each test; endurance, by scores for condition (signs of fatigue) at the end of the cross-country ride. The possible range of scores for fatigue was from 1 to 5, 1 indicating most fatigue and 5 the least. Ease of riding was measured by the riders' scores for ease of handling, performance of gait, and ease of gait to rider, at the end of the cross-country ride, for the walk, trot, and canter. These scores ranged from 1 to 5, 1 being the poorest and 5 the best.

Other data obtained in the tests and studied for association with performance were humidity, temperatures, riders, years, and the number of strides on the second, fifth, and eighth laps of the mile tests, from which the average length of stride was calculated.

Studies of association with performance were also made of the following factors: Height at withers, depth of chest, height at floor of chest, distance from point of shoulder to point of hip, heart girth, circumference of fore cannon, hind cannon, and knee, width and depth of fore cannon and depth of hock, general conformation, style and beauty, head, neck, top line of withers, top line of back, top line of croup, slope of shoulder, size and shape of feet, quality, condition (fleshing), temperament, action at walk, and action at trot. For most of these characters a score of 1 was the least desirable and a score of 9 the most desirable, but for some characters, such as temperament, a medium score was most desirable.

The data were analyzed principally by the analysis-of-variance technique given by Fisher (*2*) and Snedecor (*10*).

RESULTS

Speed

The time required to walk a mile averaged 15.1 minutes (table 2), the range among individuals being from 10.0 to 18.5 minutes. The variations by years are shown in table 3. Analyses of variance showed a significant association between the time required and the following: Sires (table 2), years (table 4), length of stride (table 5), slope of shoulder (table 6), action at the walk (table 7), riders' scores for performance at the walk (table 8), and size and shape of feet (table 18).

It was impossible to evaluate accurately the effects of sires and years on the time required to walk a mile since the same sires were not used each year (tables 1 and 3). However, the variance between the offspring of sires within the same years and same riders was significant (table 4).

Significant differences were found between the time required to walk a mile by the offspring of individual dams, but it was not possible to separate these effects from those of the sires, owing to the small number of offspring from each dam. On the average, there was not

TABLE 2.—*Average performance of offspring of different sires and analyses of variance* [1]

AVERAGE PERFORMANCE

Sire	Off-spring	Time required to—			Length of stride at—		Score for fatigue at end of 11.35-mile course [2]	Off-spring	Score for action at—	
		Walk a mile	Trot a mile	Cover 11.35-mile course	Walk	Trot			Walk [3]	Trot [3]
	Number	*Minutes*	*Minutes*	*Minutes*	*Feet*	*Feet*		*Number*		
Mansfield	12	16. 0	5. 8	115	5. 1	9. 3	4. 17	9	6. 67	6. 78
Abbott	6	15. 1	5. 5	111	5. 6	9. 9	3. 83	6	6. 83	6. 00
Canfield	16	14. 6	4. 9	100	5. 4	10. 6	4. 44	16	6. 31	6. 12
Delmont	2	15. 5	6. 1	122	5. 5	8. 8	4. 00	0		
Upwey King Peavine	2	15. 2	5. 0	111	5. 5	10. 2	4. 00	2	6. 00	7. 00
Goldfield	25	14. 7	5. 1	110	5. 4	10. 2	4. 04	19	6. 79	7. 26
Hudson	3	16. 2	5. 7	115	5. 4	10. 1	4. 33	3	6. 00	7. 00
Laddie	2	15. 4	6. 0	107	5. 4	9. 0	5. 00	2	5. 00	4. 50
Total or average	68	15. 1	5. 3	109	5. 3	10. 0	4. 18	57	6. 51	6. 61

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares [4]						Degrees of freedom	Mean squares [4]	
Between sires	7	3. 18	*1. 28	**321. 27	0. 18	*2. 51	0. 54	6	1. 47	*4. 00
Within sires	60	1. 53	. 44	73. 14	. 12	. 89	. 34	50	1. 83	1. 67
Total	67							56		

[1] Riders' scores for ease of handling, performance of gait, or ease of gait to riders not included in table, since none of the average mean differences between sires were significant.

[2] Scored on a scale of 1 to 5, 1 representing the most fatigued and 5 the least.

[3] Scored on a scale of 1 to 9, 1 representing the poorest action and 9 the best.

[4] *=Significant; **=highly significant.

TABLE 3.—*Variations, by years, in time required to walk and trot a mile and to cover an 11.35-mile course*

Year	Average time required to—		
	Walk 1 mile	Trot 1 mile	Cover 11.35-mile course
	Minutes	*Minutes*	*Minutes*
1941	15. 8	6. 0	122. 8
1942	15. 5	5. 6	113. 5
1943	15. 8	5. 7	116. 3
1944	13. 6	4. 8	108. 0
1945	14. 9	5. 1	108. 0
1946	15. 4	5. 3	107. 1
1947	14. 6	5. 1	99. 9

TABLE 4.—*Analyses of variance of time required by the offspring of different sires within the same years and with the same riders*

Source of variance	Time to walk a mile		Time to trot a mile		Time to cover 11.35-mile course	
	Degrees of freedom	Mean square [1]	Degrees of freedom	Mean square	Degrees of freedom	Mean square [1]
Between years	6	*4. 17	6	1. 08	6	**424. 73
Between riders within years	14	1. 37	14	. 59	17	100. 70
Between sires within riders and years	15	*2. 30	15	. 47	14	*87. 68
Within sires, riders, and years	32	1. 11	32	. 42	30	38. 31
Total	67		67		67	

[1] *=Significant; **=highly significant.

TABLE 5.—*Association of length of stride with speed and analyses of variance*

AVERAGE PERFORMANCE

Length, in feet, of stride at walk	Horses	Time required to—		Length, in feet, of stride at trot	Horses	Time required to—	
		Walk a mile	Cover 11.35-mile course			Trot a mile	Cover 11.35-mile course
	Number	*Minutes*	*Minutes*		*Number*	*Minutes*	*Minutes*
4.1–4.3	1	18. 50	107. 1	7.0–7.9	1	6. 30	121. 0
4.4–4.6	2	16. 25	123. 5	8.0–8.9	9	6. 38	114. 1
4.7–4.9	4	15. 45	102. 8	9.0–9.9	20	5. 64	113. 6
5.0–5.2	15	14. 86	111. 0	10.0–10.9	25	5. 05	106. 8
5.3–5.5	27	15. 23	108. 1	11.0–11.9	10	4. 61	101. 3
5.6–5.8	16	14. 59	108. 6	12.0–12.9	3	4. 20	106. 0
5.9–6.1	3	14. 53	112. 1				
Total or average	68	15. 06	109. 2		68	5. 32	109. 1

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares[1]		Source of variance	Degrees of freedom	Mean squares[1]	
Between length of stride	6	*3. 50	*235. 2	Between length of stride	5	*4. 76	**306. 6
Within length of stride	61	1. 53	85. 7	Within length of stride	62	1. 83	82. 3
Total	67				67		

[1] *=Significant; **=highly significant.

TABLE 6.—*Association of differences in slope of shoulder with time required to walk a mile and with action at walk and trot, and analyses of variance*

AVERAGE PERFORMANCE

Score for slope of shoulder [1]	Horses	Time required to walk 1 mile	Horses	Score for action at—	
				Walk [2]	Trot [2]
	Number	*Minutes*	*Number*		
3	1	17. 0	1	3. 0	3. 0
4	15	15. 8	15	6. 3	6. 5
5	24	04. 6	19	6. 8	6. 7
6	11	14. 6	10	7. 2	7. 5
7	7	14. 9	7	6. 0	6. 1
8	5	15. 2	5	6. 0	6. 4
Total or average	63	15. 0	57	6. 5	6. 6

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares [3]	Degrees of freedom	Mean squares [3]	
Between slope of shoulder	5	*4. 15	5	*4. 43	*4. 62
Within slope of shoulder	57	1. 57	51	1. 53	1. 65
Total	62		56		

[1] 1 = steep −, 2 = steep, 3 = steep +, 4 = medium −, 5 = medium, 6 = medium +, 7 = very sloping −, 8 = very sloping, 9 = very sloping +.

[2] 1 = poor −, 2 = poor, 3 = poor +, 4 = medium −, 5 = medium, 6 = medium +, 7 = good −, 8 = good, 9 = good +. Scores of 1, 2, and 3 indicate very deficient action; scores 4, 5, and 6, no major faults but in some cases sluggishness and minor faults; scores of 7, 8, and 9, straight and snappy action.

[3] * = Significant.

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TABLE 7.—*Association of action at walk and trot with other measures of performance, and analyses of variance*

AVERAGE PERFORMANCE

Score for action at walk [1]	Horses	Time to walk a mile	Length of stride at walk	Time to cover 11.35-mile course	Score [2] for—			Score for action at trot [1]	Horses	Time to trot a mile	Length of stride at trot	Time to cover 11.35-mile course	Score [2] for—		
					Ease of handling at walk	Performance at walk	Ease of walk to rider						Ease of handling at trot	Performance at trot	Ease of trot to rider
	Number	*Minutes*	*Feet*	*Minutes*					*Number*	*Minutes*	*Feet*	*Minutes*			
2	1	16.00	4.40	121.0	1.00	1.00	1.00	3	2	6.10	8.85	119.0	3.00	1.50	1.50
3	1	17.00	5.50	117.0	5.00	2.00	2.00	4	4	5.50	9.75	103.5	4.50	4.00	4.25
4	2	12.85	5.05	95.0	4.50	3.50	3.50	5	5	5.20	10.16	101.2	4.00	3.40	3.80
5	7	15.30	5.46	111.3	3.86	3.57	4.14	6	9	5.24	10.26	108.1	4.22	3.78	3.67
6	13	15.47	5.36	112.5	3.69	3.62	3.92	7	21	5.38	9.84	112.2	4.00	4.10	3.76
7	19	15.07	5.38	106.4	4.21	3.74	4.26	8	15	5.07	10.39	104.1	4.47	4.47	4.27
8	14	15.03	5.31	104.9	4.21	4.50	4.57	9	1	5.80	9.70	109.0	4.00	4.00	4.00
Total or average	57	15.15	5.34	108.0	4.02	3.79	4.12		57	5.30	10.04	108.0	4.16	3.98	3.84

Source of variance	Degrees of freedom	Mean squares [3]						Source of variance	Degrees of freedom	Mean squares [3]					
Between scores	6	*3. 26	0. 20	*185. 2	2. 22	**3. 17	**3. 12	Between scores	6	0. 62	1. 08	*191. 4	0. 88	**3. 03	*2. 46
Within scores	50	1. 20	. 11	78. 3	. 99	. 69	. 83	Within scores	50	. 41	. 99	77. 6	. 85	. 58	. 94
Total	56								56						

[1] 1 = poor −, 2 = poor, 3 = poor +, 4 = medium −, 5 = medium, 6 = medium +, 7= good −, 8 = good, 9= good +. Scores of 1, 2, and 3 indicate very deficient action; scores 4, 5, and 6, no major faults but in some cases sluggishness and minor faults; scores of 7, 8, and 9, straight and snappy action.

[2] Scored by the riders on a scale of 1 to 5, 1 being the poorest and 5 the best.

[3] *=Significant; **=highly significant.

TABLE 8.—*Association of riders' scores for performance at walk and trot with other measures of performance, and analyses of variance*

AVERAGE PERFORMANCE

Riders' scores for performance at walk [1]	Horses	Time to walk a mile	Length of stride at walk	Score for ease of handling at walk [1]	Score for ease of walk to rider [1]	Time to cover 11.35-mile course	Riders' scores for performance at trot [1]	Horses	Time to trot a mile	Length of stride at trot	Score for ease of handling at trot [1]	Score for ease of trot to rider [1]	Time to cover 11.35-mile course
	Number	*Minutes*	*Feet*			*Minutes*		*Number*	*Minutes*	*Feet*			*Minutes*
1	1	16.00	4.40	1.00	1.00	121.0	1	1	6.30	7.90	1.00	1.00	121.0
2	4	16.65	5.38	3.25	3.00	122.0	2	2	5.30	10.35	4.00	2.50	115.5
3	18	15.44	5.31	3.78	3.50	111.1	3	12	5.42	9.74	3.58	3.00	110.8
4	29	14.97	5.31	4.10	4.41	108.0	4	29	5.33	10.00	4.28	3.90	108.7
5	16	14.35	5.50	4.62	4.81	104.9	5	24	5.21	10.26	4.54	4.62	107.8
Total or average	68	15.06	5.35	4.04	4.13	109.1		68	5.32	10.03	4.19	3.91	109.1

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares [2]					Source of variance	Degrees of freedom	Mean squares [2]				
Between scores	4	**5.48	*0.34	**4.64	**7.96	*299.6	Between scores	4	0.61	1.76	**4.46	**8.66	77.0
Within scores	63	1.47	.12	.83	.51	86.3	Within scores	63	.52	1.02	.61	.52	100.5
Total	67							67					

[1] Scored by the riders on a scale of 1 to 5, 1 being the poorest and 5 the best. [2] * = Significant; ** = highly significant.

a significant difference between the groups of dams to which the sires were mated, in time required by their offspring to walk a mile (table 18), but the offspring of mares mated to Mansfield and Hudson were significantly slower than those of the same mares mated to Canfield. Colts by Mansfield also were significantly slower than those out of the same mares by other stallions (table 9).

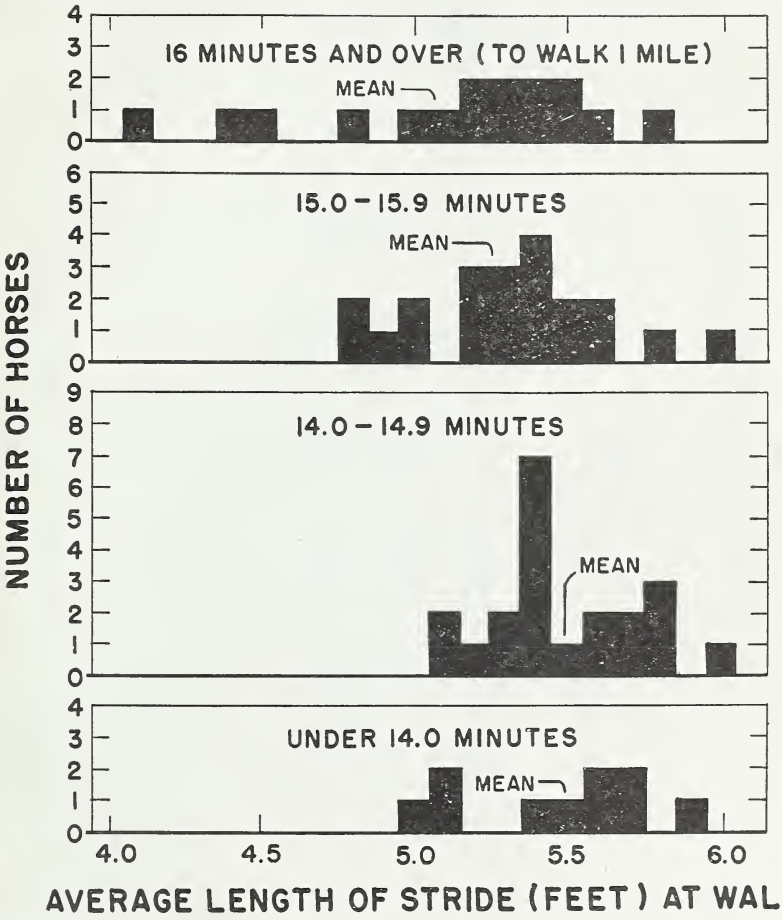

FIGURE 3.—Distribution of horses with different length of strides according to time required to walk a mile.

Horses having a medium slope of shoulder had the fastest walk, as shown in table 6. Horses covering the distance in the shortest time invariably had a fairly long stride (table 5). Slow horses, on the other hand, had either a short or a long stride. These findings are demonstrated in figure 3, which shows that slow horses (those requiring 16 minutes or more to walk a mile) varied in length of stride from 4.1 to 5.8 feet, whereas fast horses (requiring less than 15 minutes) varied from 5 to 5.9 feet. None of the sires produced all progeny with both

TABLE 9.—*Differences in performance* [1] *between offspring from indicated sire and average of those from other sires but from the same dams*

[Colts from at least 3 other sires were available for comparison]

Sire	Speed in—			Score for endurance	Score for ease of riding					
					Ease of handling at—			Performance at—		
	Walking 1 mile	Trotting 1 mile	Covering 11.35-mile course		Walk	Trot	Canter	Walk	Trot	Canter
	Minutes	*Minutes*	*Minutes*							
Mansfield	*−1. 22	**−1.08	**−12. 1	−0. 33	−0. 29	−0. 21	−0. 10	−0. 73	†−0. 77	−0. 24
Abbott	+. 16	−. 31	−3. 3	−. 22	+1. 08	+. 75	+. 44	+. 22	−. 58	+. 44
Canfield	+. 11	*+. 59	**+12. 4	+. 31	+. 44	†+. 68	+. 56	+. 69	+. 49	−. 16
Delmont	−. 30	−. 80	†−15. 3	−. 20	−1. 00	−. 10	−. 10	0	+. 70	0
Upwey King Peavine	+. 13	+. 67	+3. 2	0	−. 50	−. 50	−1. 50	−1. 00	−. 75	−. 50
Goldfield	†+. 69	†+. 40	+1. 1	−. 26	−. 21	−. 38	−. 45	−. 01	+. 05	−. 41
Hudson	−. 63	−. 20	−4. 0	+. 04	−. 43	−. 10	−. 10	−. 47	+. 47	+1. 14
Laddie	+. 02	−. 15	+13. 0	+. 75	−. 50	−. 50	+. 50	−. 25	+. 25	+1. 00

Sire	Score for ease of riding			Length of stride at—		Score for other characters		
	Ease of gait at—			Walk	Trot	Temperament	Action at walk	Action at trot
	Walk	Trot	Canter					
				Feet	*Feet*			
Mansfield	−0. 70	†−0. 86	+0. 06	**−0. 49	**−1. 60	+0. 38	−0. 50	−1. 13
Abbott	−. 08	−. 14	+. 25	+. 27	+. 15	−1. 04	−. 07	†−1. 54
Canfield	†+. 75	+. 39	+. 08	+. 05	*+. 85	−. 63	+. 68	+. 03
Delmont	−. 30	+1. 00	−. 90	+. 38	−1. 09			
Upwey King Peavine	+. 25	+. 50	0	+. 45	+. 60	−1. 50	−1. 50	−1. 50
Goldfield	−. 08	0	−. 18	−. 03	+. 32	*+. 91	+. 44	*1. 03
Hudson	+. 19	+. 33	−. 14	+. 04	+. 14	−. 34	−. 83	+. 50
Laddie	−1. 50	+. 25	+1. 00	−. 02	−. 58	+1. 33	−1. 67	−1. 33

[1] + indicates that offspring of the sire named were better than those of the other sires; −, that they were poorer; †, that the difference was nearly significant; *, that the difference was significant; **, that the difference was highly significant.

a fast walk and a long stride. Canfield had the best record, 69 percent of his progeny being in this group. Slope of shoulder and length of stride at the walk were not significantly associated although both were associated with length of time required to walk a mile.

Horses with good action at the walk generally made better time than those with poor action, as shown in table 7. Most of the difference in speed was found between the 5 horses with a score of 2 (a small narrow foot) that averaged 12.9 minutes to walk a mile and 58 horses with scores of 3 to 8 that averaged 15.2 minutes. Horses given a good score by the rider for performance at the walk made on the average consistently faster time than those given poor scores for this character (table 8).

The time required to trot a mile ranged from 3.8 to 7.3 minutes with an average of 5.3 minutes for the 68 horses. Sires (table 2), length of stride (table 5), general conformation (table 10), and years (table 18) were all significantly associated with time required. Analysis of variance showed that on the average there was not a significant difference, in time required, between offspring of different sires within the same years and with the same riders (table 4). In general, fastest average time at the trot was most closely associated with a medium score on general conformation, as shown in table 10.

TABLE 10.—*Association of general conformation and slope of croup with time required to trot 1 mile and analyses of variance*

AVERAGE PERFORMANCE

Score for general conformation [1]	Horses	Average time to trot 1 mile	Score for slope of croup [2]	Horses	Average time to trot 1 mile
	Number	*Minutes*		*Number*	*Minutes*
4	3	5. 3	3	2	6. 3
5	7	5. 1	4	4	5. 1
6	11	4. 9	5	15	5. 1
7	26	5. 4	6	21	5. 4
8	12	5. 1	7	15	5. 0
9	4	6. 2	8	6	5. 6
Total or average	63	5. 3		63	5. 3

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares [3]	Source of variance	Degrees of freedom	Mean squares
Between general conformation.	5	*1. 09	Between slope of croup.	5	0. 93
Within general conformation.	57	. 41	Within slope of croup.	57	. 42
Total	62			62	

[1] 1=poor−, 2=poor, 3=poor+, 4=medium−, 5=medium, 6=medium+, 7=good−, 8=good, 9=good+.

[2] 1=steep−, 2=steep, 3=steep+, 4=medium slope−, 5=medium slope, 6=medium slope+, 7=level−, 8=level, 9=level+.

[3] *=Significant.

Horses with a long stride at the trot (11.0 feet or more) averaged 2 minutes faster than those with a short stride (less than 9 feet), as shown in table 5. None of the horses with short strides made fast time and none with long strides made very slow time. Canfield's progeny showed up better than those of the other sires, 62 percent of his offspring having long strides and making fast time. None of the progeny of Mansfield, Delmont, Hudson, or Laddie had a stride of more than 10 feet or trotted a mile in less than 5 minutes.

The sex of horses (table 11) and the slope of croup (top line of croup) (table 10) appeared to have some association with speed, although for neither of these characters was the average difference quite significant. Mares and geldings trotted at about the same speed, but the six stallions were on the average 0.6 minute slower. A medium slope of croup seemed to be the most favorable to speed at the trot, although the results were not consistent.

TABLE 11.—*Association of sex and performance and analyses of variance* [1]

AVERAGE PERFORMANCE

Sex	Horses	Time required to—			Length of stride at—		Score for fatigue at end of 11.35-mile test [2]
		Walk a mile	Trot a mile	Cover 11.35-mile course	Walk	Trot	
	Number	*Minutes*	*Minutes*	*Minutes*	*Feet*	*Feet*	
Stallion	6	15. 0	5. 9	108. 3	5. 3	9. 1	4. 7
Gelding	20	15. 3	5. 2	107. 4	5. 5	10. 3	4. 3
Mare	42	15. 0	5. 3	110. 1	5. 3	10. 0	4. 0
Total or average	68	15. 1	5. 3	109. 1	5. 4	10. 0	4. 2

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares [3]					
Between sexes	2	0. 56	1. 06	52. 2	0. 24	*3. 59	*1. 22
Within sexes	65	1. 74	. 51	100. 5	. 12	. 98	. 33
Total	67						

[1] Riders' scores for ease of handling, performance of gait, and ease of gait to riders were omitted from the table because none of them were found to be significantly associated with sex (table 18).

[2] 1=extremely exhausted, 2=exhausted, 3=marked signs of fatigue, 4=slight signs of fatigue, 5=no sign of fatigue.

[3] *=Significant.

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The time required to cover the 11.35-mile cross-country course ranged from 83 to 129 minutes and averaged 109. It was significantly associated with sires (table 2), years (table 4), length of stride at the walk and trot (table 5), action at the walk and trot (table 7), score for performance at walk (table 8), top line of back (table 12), and riders (table 18). The average time required by the offspring of different sires ranged from 100 to 121.5 minutes (table 2). For years, the time required ranged from 122.8 for 1941 to 99.9 for 1947 and showed a constant decrease except for 1942 (table 3). The riders had a significant effect on the time made on the cross-country ride. They changed over the years. Some were used but 1 year; one was used 6 years. Obviously, it is impossible to separate entirely the effects of sires, years, and riders on the time required to cover the course. However, the average differences between the time required by the offspring of the different sires within the same years and with the same riders were significant (table 4).

TABLE 12.—*Association of top line of back and slope of croup with time required to cover 11.35-mile course and analyses of variance*

AVERAGE PERFORMANCE

Score for top line of back [1]	Horses	Average time required to cover 11.35-mile course	Score for slope of croup [2]	Horses	Average time required to cover 11.35-mile course
	Number	*Minutes*		*Number*	*Minutes*
4	7	111. 1	3	2	122. 0
5	13	113. 5	4	4	106. 2
6	18	104. 9	5	15	109. 7
7	16	108. 3	6	21	109. 2
8	9	103. 4	7	15	103. 1
			8	6	108. 5
Total or average	63	108. 0			
				63	108. 0

ANALYSES OF VARIANCE

Source of variance	Degrees of freedom	Mean squares [3]	Source of variance	Degrees of freedom	Mean squares
Between top line of back.	4	*207. 6	Between slope of croup.	5	167. 2
Within top line of back.	58	81. 3	Within slope of croup.	57	82. 7
Total	62			62	

[1] 1=low, long −; 2=low, long; 3=low, long +; 4=medium −; 5=medium; 6=medium +; 7=short, level −; 8=short, level; 9=short, level +.

[2] See footnote 2 of table 10.

[3] *=Significant.