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Author(s)	Murata, Setsuko; Watanabe, Yutaka
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Genetic Analysis of the Thoroughbred Population in Japan

IV Inbreeding and Relationship

Setsuko MURATA and Yutaka WATANABE
(Eaculty of Agriculture, Hokkaido University)

Thoroughbred breeding in Japan has been attached great importance to the pedigree as a element of performance from the speciality of the use and breeding origin.

For the purpose of explaining the speciality of the breeding structure in such thoroghbred population, we have studied genetic contribution in the report I and II and obtained that the line-breeding has not been adopted. From this result it is assumed that the inbreeding is apt to be avoided. As shown in the List of the Horses Registered for Breeding, the frquency of the foreign-bred parents is 30–80% in each sample year (Table 1), so the influence of those may be fairly great. Accordingly it may be said that the population is open to the outside as the breeding population. Moreovert, the artificial insemination has not been permitted in thoroughbred different from the case of the cattle, so it may be considered that the breeding structure of the thoroughbred is naturally different from that of the cattle. We have tried to make the above points clear by means of calculating the coefficient of inbreeding and *inter-se* relationship.

TABLE 1. Frequency of imported horses

Sample years		1949–'53	1957	1960	1963	1966	1969
Sample herself	(%)	6	32	9	10	14	9
Sire	(%)	49	10	13	33	41	53
Mare	(%)	6	1	3	3	4	1
Both parents	(%)	15	1	6	8	10	14
Total	(%)	76	44	31	54	69	77

Materials for analysis

Complete pedigree for the past five generations of the 100 samples were taken at random from the List of the Horses Registered for Breeding of every

four year, 1949–'53, '57, '60, '63, '66 and '69, in the same way as the report I[1] and II[2]. As the number of registry in 1957 was 78, the sample size was 78.

Method

1) The coefficient of inbreeding (F) is computed by use of the computer (Facom-230-60) as shown in the report III[3]. The average coefficient of inbreeding per sample year is the mean of the coefficient of inbreeding of the sample mares. In order to know the influence of the foreign-bred horses the average inbreeding coefficient of the horses is estimated in the case of which the sample horses herself and both parents and either parents are imported, provided that the carried horse is regarded as a domestic horse.

2) To estimate the average *inter-se* relationship (R), 100 pairs were sampled at random from all the possible combinations among the sample mares (4950 pairs) and *inter-se* relationship by WRIGHT[4] were calculated. As to a proportion of the current inbreeding, due to half-sib matings in the parental generation, 100 random sampling pairs were almost concided with all the pairs, and the error was very little, so the current inbreeding was not considered.

3) The long-term inbreeding (F) expected from the average *inter-se* relationship (R) among random members was obtained from R/(2–R). And the index of subdivision (F/F′) was estimated.

4) The average *inter-se* relationship among parents in the above 100 random sampling pairs of each sample year was estimated. 4 pairs were taken, namely, sire and sire (R(♂♂)), dam and dam (R(♀♀)), a sire and the other dam (R(♂♀)), a dam and the other sire (R(♀♂)).

Average *inter-se* relationship is the mean of the 100 R(♂♂), 100 R(♀♀) and 200 R(♂♀). The inbreeding (F″) expected from R(♂♀) in random mating estimated from R/(2–R).

5) Average generation length was obtained from the average age of the parents at the birth of their offspring, with the exception of excluding the imported horses.

Result

Average inbreeding (F), average *inter-se* relationship (R) and the inbreeding (F′) expected from it, average *inter-se* relationship between parents R(♂♂), R(♀♀) and R(♂♀) and inbreeding (F″) expected from them and F/F′, F/F″ are shown in Table 2.

1) It took about 90 seconds to calculate the average inbreeding (F) of the 100 samples of each sample year including output time of the line-printer. Such a case of current inbreeding as LUSH[5] says was not found in these

TABLE 2. Average inbreeding and *inter-se* relationship

Kinds of coefficient ( )	Sample years					
	1949–'53	1957	1960	1963	1966	1969
Average inbreeding F (N=100)	0.5742	0.7712	1.0000	0.9746	0.8341	0.8828
Average *inter-es* relationship, R(N=100)	3.8792	2.8399	3.5945	3.6838	3.0456	2.1739
Average relationship among parents:						
Among male parents, R(♂♂) (N=100)	6.1260	4.4893	5.9871	5.4937	5.6279	3.8986
Among female parents, R(♀♀) (N=100)	2.8104	1.4279	2.6360	2.6855	2.5002	2.2938
Between male and female parents, R(♂♀) (N=100)	3.2589	2.4713	2.4930	3.0844	2.3263	1.7938
Inbreeding expected:						
F′ (fromt R)	1.9780	1.4404	1.8301	1.8764	1.5464	1.0989
F″ (from R(♂♀))	1.6565	1.2511	1.2622	1.5663	1.1769	0.9050
F/F′	0.2963	0.5354	0.5464	0.5194	0.5394	0.8033
F/F″	0.3466	0.6164	0.7923	0.6222	0.7087	0.9755

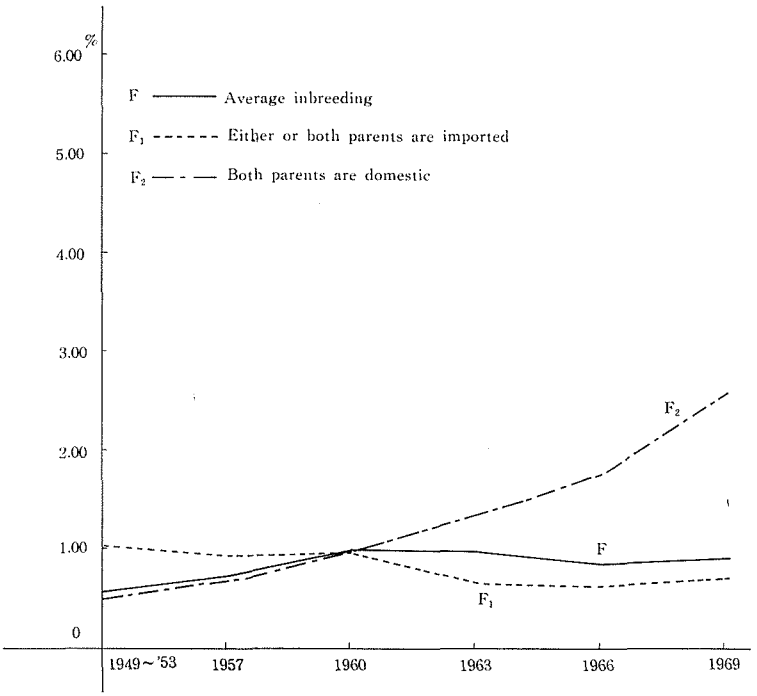

Fig. 1. Inbreeding of the imported horses compared with the domestic horses.

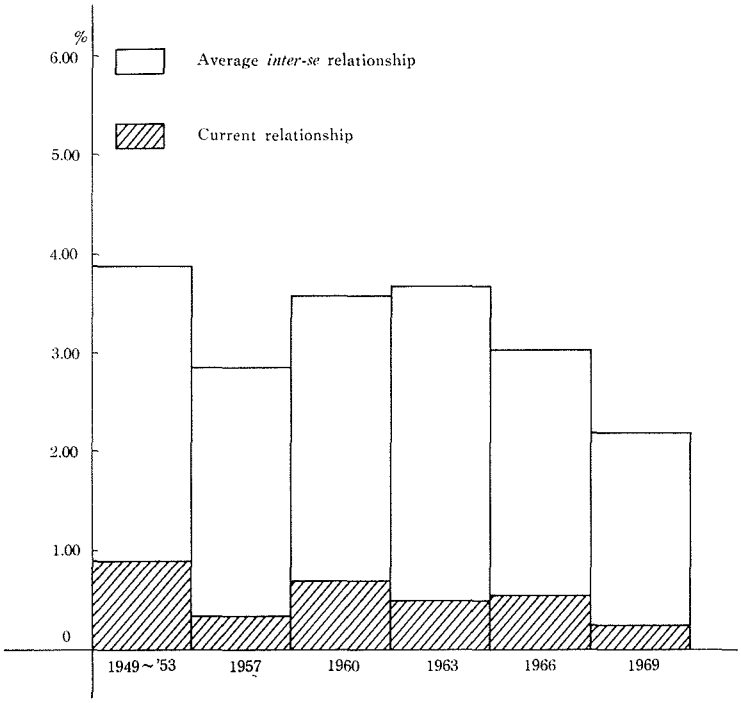

Fig. 2. Proportion of current relationship.

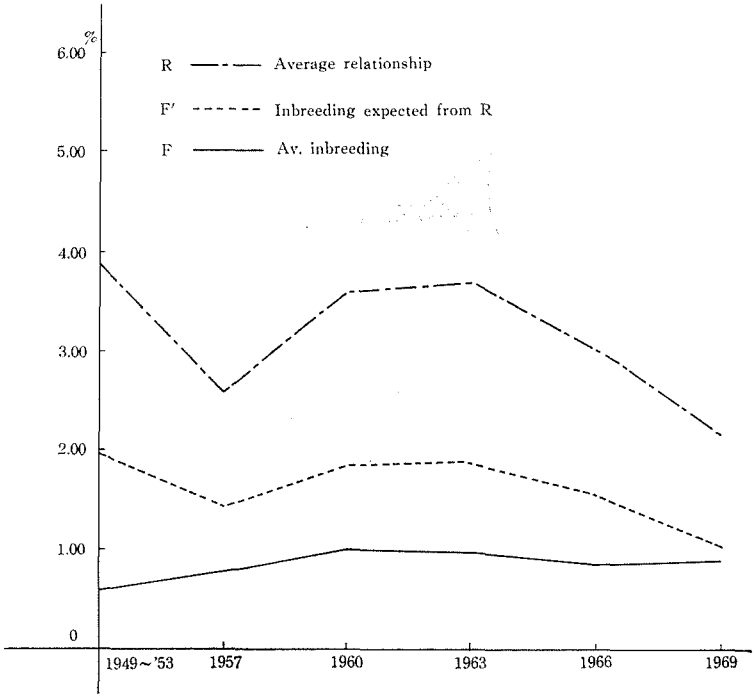

Fig. 3. Comparison of average inbreeding with *inter-se* relationship.

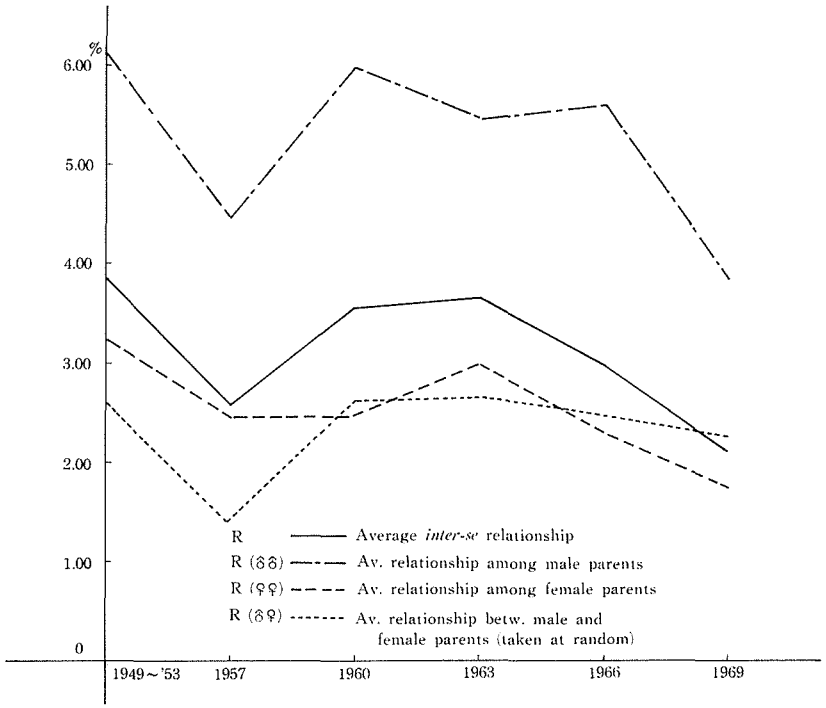

Fig. 4. Average *inter-se* relationship among parents.

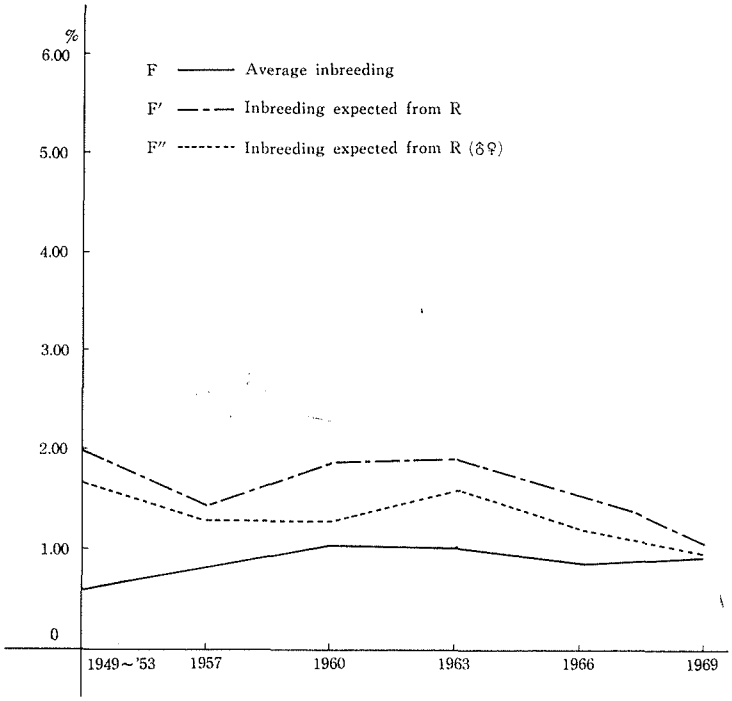

Fig. 5. Expected inbreeding compared with average inbreeding.

sample mares and all the cases were long-term inbreeding. On the whole, low inbreeding was shown. It tends to increase from 1949–'53 to 1960 and has slightly decreased since 1960. Inbreeding of the horses of which both parents are domestic (F_2) and those of which are not so (F_1) are separately shown in figure 1. As seen in this figure, F_1 decreases little by little, and in contrast to this, F_2 increases year by year. F indicates the peak in 1960 and decreases drawing a curve similar to the F_1's. From this, increase of F from 1949–'53 to 1960 was chiefly attributable to F_2 but decrease of it since 1960 was to F_1. This phenomenon depends on the immigration of the foreign-bred horses to the population increased year by year and on the avoidance of the inbreeding. As to the domestic horses, on the contrary, it is shown that the selection has been practiced.

2) As shown in Table 2, average *inter-se* relationship (R) shows a fairly high value in comparison with the average inbreeding (F). A proportion of current relationship in each sample year are shown in figure 2. The increase or decrease of R is influenced by current relationship to some extent but the ratio of it is very little.

3) The inbreeding (F′) expected from the average *inter-se* relationship (R), R and F are comparatively shown in figure 3. F′ is higher than F. Both R and F′ tend to decrease except 1957. In the case of 1957, all registered mares are 78 as stated previously, of which about 30% were foreign-bred horses, so this case may be peculiar. It is considered that the value of R influences on F but that sudden decrease since 1963 is attributable to the influence of the sudden increasing foreign-bred horses.

4) Average *inter-se* relationship among parents is given in figure 4. R (♂♂) shows a very high value in each sample year, R (♂♀) and R (♀♀) show lower amount than R. This means that a sire is more selected than a mare and it is attributable to raise the amount of R. R (♂♀) which indicates lower value than R is attributable to decrease R and has influence on decrease of F. In Fig. 5 are given comparatively the average inbreeding (F), inbreeding (F′) expected from R and inbreeding (F″) expected from R (♂♀). F′ and F″ show a higher value than F in each year. From this, F/F′ and F/F″ is smaller than 1, so the tendency of the inbreeding avoidance may be pointed out. F′ decreased abruptly during 1949–'53～

TABLE 3. Generation interval

Sample year	Average age of	
	Sires	Dams
1949–'53	10.00	10.76
1957	11.20	11.41
1960	12.51	10.10
1963	10.82	9.84
1966	11.03	10.15
1969	10.88	9.52
Average	11.09	10.30
Over-all average	10.70	

1957 and increased during 1957～'63 and decreased after that, and the differences of it from F is slight. As to F″, the same tendency is seen on the whole. On the other hand, F tended to increase during 1949–'53～1957 and then began to decrease little by little. F/F′ and F/F″ given in Table 2 increased year by year. From this, the population may be considered to get near to random mating.

5) Average generation length is given in Table 3. About 10 years is twice as many Holstein cattle as reported by ABE[6]. With regared to this, we will report another time.

Consideration

The inbreeding and *inter-se* relationship of the thoroughbred were reported by STEELE[7], and these value is very high in comparison with our report. In contrast to the value of Holstein reported by ABE[6], NOZAWA[8),9)] or foreign researchers[5], the inbreeding is low and *inter-se* relationship is not so. In this report, the tendency of the inbreeding avoidance was followed to the previous report I and II in which the line-breeding has not been done in the thoroughbred population. It may be considered manifestation that so-called current inbreeding, due to sib or parent-offspring matings in the parental generation, has never been practiced so far. Considering domestic horses, however, the only limited individuals which had super performance have been used for breeding. Accordingly the increase of inbreeding is regarded to be caused by the selection done to a certain extent. On the other hand, as the importation of the foreign-bred horses results in the immigration to the population from out side and inbreeding avoidance has consequently been done, the inbreeding may be considered to decrease. The wide use of artificial breeding techniques in cattle, as NOZAWA pointed out, had an effect on both directions of increasing and decreasing the inbreeding. Namely, there are two cases in which the diminution of the bull makes to increase the *inter-se* relationship and central management of the bull and in which the enlargement of the provinces for breeding makes to diminish the chance of inbreeding. In thoroughbred artificial insemination has not been permitted but the same thing as this may be said from the view point of the phenomenon. Namely, it is the increase of the inbreeding by the selection of the domestic horse and the decrease of the inbreeding by the immigration act of the foreign-bred horse. In the case of thoroughbred, foreign-bred horses began to increase after the War II, and its effect has become strong since about 1963 and the average inbreeding is to decrease. Accordingly, the tendency of the inbreeding avoidance is consequently attributable to the increase of foreign-bred horses. In the breeding of the racing horse, as stated previously, the pedigree has been

specially attached to great importance. Though it has a tendency that line-breeding has not been practiced and the inbreeding has been avoided, the breeding to have regarded for pedigree in thoroughbred does not aim at the homogeneity of the entire population but has bred the descendant which has many super ancestors. Recently, though the inbreeding avoidance tends to shift to random mating gradually yet the inbreeding avoidance will go on still more. In this sample, the average generation length is pretty long and extends over ten years. When only the long-term breeding is used, it is not until after three generations that the influence of it manifests in inbreeding. Accordingly it comes to have barely begun that even the inbreeding of the latest sample mares taken from 1969's had the influence of 1939's. Speaking about 1939's the inbreeding of the domestic horses increased because it was the time when the horses for military use were remarkably bred and improved. The influence of the tendency in recent years that foreign-bred horses which was caused by the prosperity of the horse-racing and the respect of foreign-bred horses and besides the liberalization of trade will be expected to manifest in inbreeding after 20～30 years, when we have much interest how the breeding structure in thoroughbred population will be.

Summary

Thoroughbred breeding in Japan has been attached great importance to pedigree. For the purpose of explaining its breeding structure, we have studied the genetic analysis by means of calculating inbreeding and *inter-se* relationship. Complete pedigree for the past five generations of the 100 samples was taken at random from the List of the Horses Registered for Breeding of every four year, 1949–'53, '57, '60, '63, '66, and '69. (1957, 78 heads) Inbreeding and *inter-se* relationship were estimated by WRIGHT's formula. Amounts of those decreased little by little, though it increased at a time during 1960–'63. By means of analysing this, it is clear that there is a tendency of inbreeding avoidance in the population. And from the above point, it may be said that the breeding having regard for pedigree in thoroughbred does not aim at the homogeneity of the entire population but has bred the descendant which has many super ancestors.

References

1) MURATA, S. and WATANABE Y. Research Bulletins of the Livestock, Faculty of Agriculture, Hokkaido University. 6, 1972.
2) MURATA, S. and WATANABE, Y. Jap. J. Zootech. Sci., 43: 12, 1972.
3) MURATA, S. and WATANABE, Y. in press.

4) WRIGHT, S. Amer. Nat. 56 : 330, 1922.
5) LUSH, J. L. Ibid. 80 : 318, 1946.
6) ABE, T., OFUKU, S. and JIMBU, M. Jap. J. Zootech. Sci., 36 : 2, 1965.
7) STEELE, D. G. Bull. Ky. Agric. Exp. Sta. 462, 1944.
8) NOZAWA, K. Jap. J. Zootech. Sci., 36 : 5, 1965.
9) NOZAWA, K. : Ibid.