The Phylogeny of the East Asian Cattle Studied by Blood Typing

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It is considered that the cattle in the world are classified into three groups; European breeds belonging to Bos taurus, Indian breeds belonging to Bos zebu indicus and the cross breeds between them. As to the distribution of cattle in Asia, Indian breeds prevail in India, Burma, Malaysia, Java, Borneo, Celebes and New Guinea.

On the other hand, it is believed that some breeds which originated from European breeds are distributed from Mongolia, the northern part of China to Korea, and the cross breeds in the southern part of China and Indochina.

So far, these observations have been made according to morphological, archeological and historical studies. In the present study, the blood groups and blood protein polymorphism of the East Asian cattle were examined for the first time and compared with those of the European cattle. From the viewpoint of the gene frequencies, genetic relationships among breeds were discussed and some speculations of the origin and phylogeny of the Japanese native cattle were made.

Blood groups and blood protein polymorphism in East Asian cattle

Blood samples were taken from the Taiwan Yellow cattle, Korean cattle in southern part, three Japanese breeds and Holstein cattle in Japan. The 36 reagents for blood typing were used to detect the blood antigens at 9 gentic loci[1] Serum transferrin types (Tf) (Jamieson, 1965),[2] hemoglobin types (Hb) (Gahne, 1961)[3] and serum albumin types (Alb) (Ashton, 1964)[4] were determined by the starch gel electrophoresis techniques. The methods used here have been described in detail in another paper (Abe *et al*, 1968).[5]

Table 1 shows the gene frequencies of blood groups, serum transferrin, hemoglobin and serum albumin types in the East Asian cattle which were examined. As shown in this table, the A and Z′ factors under the A system were conspicuously found in the East Asian cattle compared with the European breed; Holstein. The Z′ factor, which was discovered originally in the Indian Zebu cattle, appeared with the highest frequency in a Japanese in digenous cattle, "Mishima cattle". This may be due to severe isolation of this breed, but the reason is not clear.

Among Holstein cattle only three phenotypes; F^+, F^+V^+ and V^+, were found in the F–V system; however, in the East Asian cattle another phenotype F^-V^- was observed. This suggested that different gene such as F_2, V_2 existed in the Asian cattle. The frequency of the V gene was very high in the Yellow cattle. The J gene in the J system seems to appear frequently among the East Asian cattle compared with the Holstein cattle. In the L, Z, R′–S′ systems, the frequencies of the L, Z and R′ genes were highest in the Yellow cattle, and the L gene in other breeds showed rather a low frequency.

In the B, C and S–U systems' phenogrouping could not be made due to lack of family data and the gene frequencies could not be cal-

Table 1. Gene frequencies of blood groups, serum transferrin, hemoglobin and albumin types in East Asian cattle

Systems	Genes	Frequencies in					
		Taiwan Yellow	Korean Cattle	Japanese Brown	Japanese Black	Japanese Mishima	Holstein**
A*	A	0.758	0.928	0.860	0.967	1.000	0.430
	Z′	0.217	0.227	0.247	0.430	0.650	0
F-V	F	0.404	0.773	0.640	0.672	0.868	0.870
	V	0.596	0.227	0.360	0.328	0.132	0.130
J	J	0.253	0.254	0.293	0.194	0.163	0.089
L	L	0.712	0.031	0.006	0.078	0.089	0.272
Z	Z	0.818	0.524	0.611	0.600	0.067	0.293
R′-S′	R′	0.042	0.016	0.011	0.020	—	0.036
Tf	Tf^A	0.171	0.304	0.202	0.373	0.480	0.356
	Tf^{D1}	0.061	0.242	0.281	0.286	0.510	0.626
	Tf^{D2}	0.553	0.253	0.447	0.327		
	Tf^E	0.167	0.196	0.067	0.014	0.010	0.019
	Tf^X	0.048	0.005	0.003	0	0	0
Hb	Hb^A	0.588	0.905	0.910	0.975	—	1.000
	Hb^B	0.329	0.082	0.087	0.025	—	0
	Hb^C	0.083	0.082	0.003	0	—	0
Alb	Alb^A	0.186	0.980	1.000	1.000	—	1.000
	Alb^B	0.806	0.020	0	0	—	0
	Alb^X	0.008	0	0	0	—	0
No. of animals		126	159	178	122	171	438

* Frequencies of antigenic factors are shown in A system.
** The European cattle raised in Japan.

culated. It was noted, however, that the Q and T factors of the B system, the C and X_2 factors of the C system, and the S and U_2 factors in the East Asian cattle appeared with high frequencies compared with those of the European breeds.

The above results revealed that the blood types of the East Asian cattle were distinctly different from those of the European cattle which have been reported elsewhere, and the blood types of the Taiwan Yellow cattle were similar to those of the Indian Zebu, but were different from the other Asian breeds examined.

As to protein polymorphism, the 15 phenotypes of transferrin were found in the East Asian cattle. Ten of them appeared to be controlled by 4 co-dominant alleles, Tf^A, Tf^{D1}, Tf^{D2}, and Tf^E like those of the European breeds. The other 5 phenotypes had slower bands than Tf^E bands as shown in Fig. 1. This new band called temporarily TfX might have originally

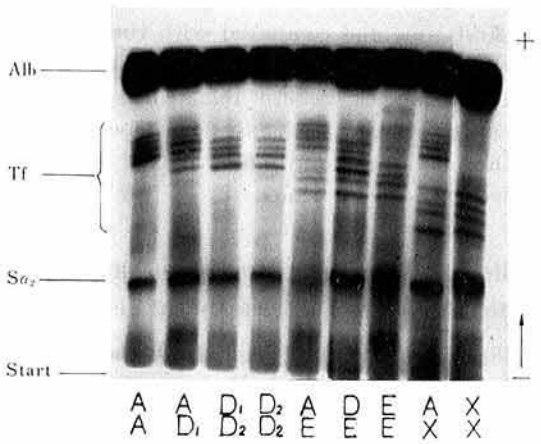

Fig. 1. Electrophoretic pattern of serum transferrin phenotypes in East Asian cattle (AX and XX are new variants.)

existed in the Zebu breeds.

Fig. 2 shows the 8 phenotypes of hemoglobin variants found in the East Asian cattle. The

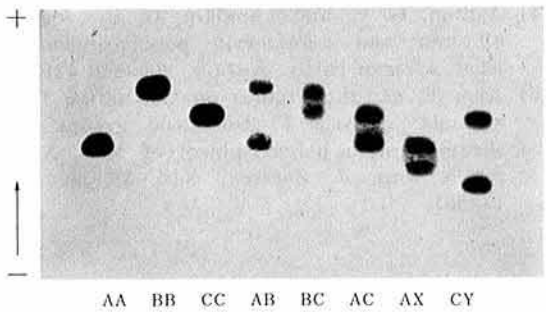

Fig. 2. Hemoglobin phenotypes in East Asian cattle (AX and CY are new variants.)

AX and CY are new variants found in only 2 Korean cattle. The other 6 phenotypes were controlled by 3 co-dominant alleles; Hb^{A}, Hb^{B} and Hb^{C}.

Fig. 3 shows the 4 phenotypes of serum albumin. Three of them were controlled by 2

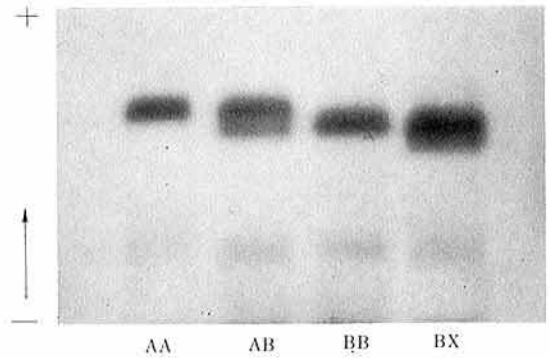

Fig. 3. Serum albumin phenotypes in East Asian cattle (BX is a new variant.)

co-dominant alleles; Alb^{A} and Alb^{B}. The BX is a new variant, which was found in 2 samples of the Yellow cattle.

As shown in Table 1, the protein types of the Yellow cattle are characterized by the relatively high frequencies of Tf^{D2}, Tf^{E}, Alb^{B}, Hb^{B} and Hb^{C} genes. The new variants, Tf XX, Tf EX, Alb BX were also found in this breed.

Genetic relationships among East Asian breeds

Genetic differences among breeds may be estimated by summing up the absolute differences of gene frequencies for each of the two-breed comparisons. The calculated amounts are shown in Fig. 4.

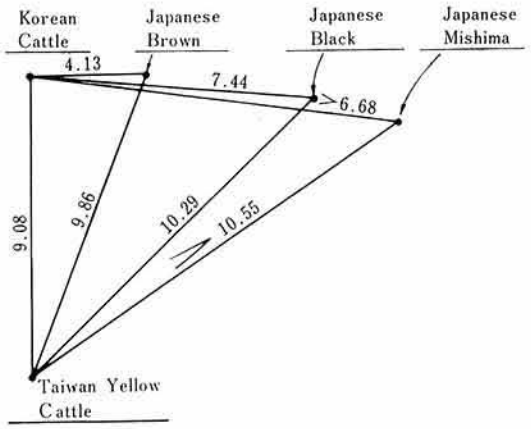

Fig. 4. Absolute differences in gene frequencies among East Asian breeds.

From the results, it was confirmed that the Japanese breeds, especially the Japanese Brown cattle, were more like the Korean cattle genetically than the Yellow cattle is to the other two. It is also believed that the differences among Japanese breeds may be due to the degree of the influence of the European cattle used for improvement and to the degree of isolation of the breed.

In the Japanese breeds the Alb^{B} gene is absent and the frequencies of Hb^{B} and Hb^{C} are much smaller than those of the Taiwan Yellow cattle. This suggests that the Japanese cattle might have originated from some other breed than the Yellow cattle.

Concerning the origin of the Japanese cattle it has been said that the Yellow cattle (zebu) raised in the southern part of Asia migrated into Japan from China via Korea. The present result of investigation indicates that this so-called Southern Route theory is difficult to be supported. In order to clarify further the

phylogeny of the Japanese indigenous cattle and the Korean cattle it would be important to make blood group studies on the cattle population raised in the northern part of Korea, Manchuria, Mongolia and the central part of the Asian continent.

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