Polymorphisms of Genetic Markers in the Red Cell Antigen, Serum Protein and Red Cell Isoenzyme of the Cats

Shigenori IKEMOTO, Haruhiro YOSHIDA, Syuichi TSUCHIDA, Yukio SAKURAI
and Masanobu FUKUI¹⁾

Laboratory of Human Biology and Department of Legal Medicine, Jichi Medical School, Tochigi 329-04, and

¹⁾Institute of Basic Medical Science, University of Tsukuba, Ibaraki 305, Japan

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ABSTRACT. Genetic polymorphisms of Ca, transferrin (Tf), postalbumin (Pa), phosphogluconate dehydrogenase (PGD), esterase-D (EsD) and phosphoglucomutase (PGM) loci were studied in samples of randomly chosen individuals from domestic cats. The gene frequencies were: $Ca=0.052$, $ca=0.948$, $Tf^A=0.448$, $Tf^B=0.552$, $Pa^A=0.229$, $Pa^B=0.771$, $Pgd^A=0.946$, $Pgd^B=0.054$, $EsD^1=0.545$, $EsD^2=0.455$, and $PGM^1=1$, respectively.—**KEY WORDS:** cat blood groups, cat genetic markers.

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Serological and biochemical analysis on genetic markers of the blood typical antigen in the red cell membrane, serum protein group specific component (Gc), transferrin (Tf) in the serum proteins, glucose-6-phosphate dehydrogenase (G6PD), esterase-D (EsD) and phosphohexose isomerase (PHI) in the red cell isoenzymes of the domestic cats have already been reported by many researchers [4, 5, 8, 9]. Recently, Hamanaka *et al.* [2] found that N-glycolylneuraminic acid (NGNA) was the N-terminal residue (NeuGc $\alpha 2-8$ NeuGc $\alpha 2-3$ Gal $\beta 1-4$ Glc-Cer) of the carbohydrate released from the cat red cells, and the NGNA was closely related to blood group. In the previous report [5], the frequencies of phenotype and genotype of the Ca blood group were studied. The Ca blood group was based upon polymorphisms observed on the red cell membrane of cats. The purpose of the present paper was to elucidate the polymorphisms of genetic markers in the red cell antigen, serum protein and red cell isoenzyme.

The blood samples were obtained without anticoagulant from the vena cephalica antebrachii of domestic cats in Japan bred and

reared. Serum samples were separated by centrifugation at 3,000 rpm for 5 minutes. Serological tests were carried out by the methods of Kojima [6]. The Ca blood group was determined with the anti-Ca serum made by our laboratory. The transferrin (Tf) and postalbumin (Pa) polymorphisms were determined by polyacrylamide gel electrophoresis performed by the methods of Weghe *et al.* [8]. The phosphogluconate dehydrogenase (PGD), esterase-D (EsD), phosphoglucomutase (PGM), acid phosphatase (AcP) and glyoxalase (GLO) polymorphisms were performed on starch gel electrophoresis according to the methods described of Harris *et al.* [3] for PGD, EsD, PGM and AcP, and Kompf *et al.* [7] for GLO.

Results of phenotype and gene frequencies were summarized in Table 1. Diagrams of the electrophoretic patterns of the Tf, Pa, PGD, EsD, PGM, AcP and GLO phenotypes were shown in Figure 1. Blood group: when the Ca system was examined in the 236 samples, the phenotype frequencies were 10.17% for type Ca and 89.83% for type ca. The gene frequencies of Ca and ca were 0.052 and 0.948, respectively. Serum pro-

Table 1. Phenotype distribution and gene frequencies for the polymorphic red cell antigen, serum proteins and red cell isoenzymes in the cats blood

System		Tested No.	Phenotype	Obs.	Phenotype Frequency %	Exp.	Gene Frequency
Red cell	Ca	236	Ca	24	10.17	23.91	$Ca = 0.052$
			ca	212	89.83	212.09	$ca = 0.948$
Serum Protein	Tf	48	A	11	22.92	9.63	$Tf^A = 0.448$
			B	16	33.33	14.63	$Tf^B = 0.552$
			AB	21	43.75	23.74	
	Pa	72	A	2	13.90	3.78	$Pa^A = 0.229$
			B	41	59.90	42.78	$Pa^B = 0.771$
			AB	29	29.20	25.44	
Red cell isoenzyme	PGD	102	A	91	89.22	91.30	$Pgd^A = 0.946$
			B	0	0	0.30	$Pgd^B = 0.054$
			AB	11	10.78	10.40	
	EsD	99	1	31	31.31	29.46	$EsD^1 = 0.545$
			2	22	22.23	20.45	$EsD^2 = 0.455$
			2-1	46	46.46	49.09	
	PGM	102	1	102	100		$PGM^1 = 1$
			2	0	0		$PGM^2 = 0$
			2-1	0	0		
	AcP	102	single band	102	100		
			variant	0	0		
	GLO	102	single band	102	100		
			variant	0	0		

tein polymorphisms: when the Tf and Pa systems were examined in the 48 and 72 samples, the phenotype frequencies were 22.92% for type Tf-A, 33.33% for type Tf-B and 43.75% for type Tf-AB, 13.90% for type Pa-A, 56.90% for type Pa-B and 29.20% for type Pa-AB. The gene frequencies of the Tf^A , Tf^B , Pa^A and Pa^B were 0.448, 0.552, 0.229 and 0.771, respectively. However, for definite evaluation of the frequencies of those factors more experimental data will be needed. Isoenzyme polymorphisms: when the PGD system was examined in the 102 samples, the phenotype frequencies were 89.22% for type PGD-A, 10.78% for type PGD-AB, but the PGD-B type was not observed in domestic cats in Japan. The gene frequencies of Pgd^A and Pgd^B were 0.946 and 0.054,

respectively. When the EsD system was examined in 99 samples, the phenotype frequencies were 31.31% for type EsD-1, 22.23% for type EsD-2 and 46.46% for type EsD-2-1. The gene frequencies EsD^1 and EsD^2 were 0.545 and 0.455, respectively. When PGM system in the 102 samples were tested and only PGM-1 type was observed in all samples, and none of the other allelic gene was found in any samples. The AcP and GLO systems were examined in the same 102 samples, in all the samples showed a single band. No variants were found in the cats. More samples might the necessary to find polymorphisms in these systems. In all these systems, observed frequencies were in agreement with those expected on the basis of Hardy-Weinberg proportions.

Fig. 1. Diagrams of the electrophoretic patterns of the Tf, Pa, PGD, EsD, PGM, AcP and GLO phenotypes.

Holmes [4] reported that the method was described which have been used to investigate isohemagglutination reaction in the blood of the cats, Ikemoto *et al.* [5] confirmed the study by reexperiment. Thuline *et al.* [8] and Weghe *et al.* [9] studied various kind of polymorphisms in serum protein and isoenzyme in the blood of the cats. The authors obtained satisfactory results in reexperiments, and it was proved that there was an interesting similarity between them. These

results provide useful information for the research of individual difference and population genetics.

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要 約

ネコの血液系遺伝標識の多型 (短報): 池本卯典・吉田治弘・土田修一・櫻井幸男・福井正信¹⁾ (自治医科大学人間生物学的研究室, 法医学教室, ¹⁾筑波大学医学専門群基礎医学系) ——日本で飼育されているネコについて, 赤血球膜抗原としての Ca 型, 血清蛋白型としての Tf 型, Pa 型, 赤血球酵素型としての PGD 型, EsD 型, PGM 型, AcP 型, GLO 型などの表型型出現頻度ならびに遺伝子頻度を検出した。その結果, 遺伝子頻度は $Ca=0.052$, $ca=0.948$, $Tf^A=0.448$, $Tf^B=0.552$, $Pa^A=0.229$, $Pa^B=0.771$, $Pgd^A=0.946$, $Pgd^B=0.054$, $EsD^1=0.545$, $EsD^2=0.455$, $PGM^1=1$, $PGM^2=0$ であった。なお, AcP と GLO 型については調査の範囲内では多型は見出せなかった。